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## **Cognitive development beyond infancy**

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### **Introduction**

As children reach their second birthday, their conceptual and perceptual abilities continue to strengthen, resulting in a rapid increase in the development of cognitive skills beyond infancy. They transform into talking, wilful beings who can constantly surprise parents and educators with their depth of knowledge and conventional (and unconventional) linguistic outbursts. Some of the most significant cognitive achievements during this time include symbolic understanding across multiple domains (does this reflect a preference for ‘domain-specific theories’? and extraordinary growth in language acquisition. Stemming from these achievements, we can question whether symbolic understanding is a domain-general or domain-specific process, whether pictorial understanding is grounded in intentionality, and whether the abilities that support language development reflect a dedicated system for language learning.

This chapter will review the development of early symbolic understanding across the domains of pictures, gestures and words. Within pictures, evidence for two different routes for linking pictures to referents (use of intentionality versus a focus on pictorial realism) will be discussed. The section on word learning will elaborate on

the use of lexical constraints and socio-pragmatic cues to facilitate word-referent mappings, and the ability of children to ‘fast map’ words after limited exposure. Finally, the chapter will review the evidence concerning whether separate symbolic skills arise from the same source.

It would be good at this point to have a transitional paragraph of a couple of sentences telling the reader what to expect in the remainder of the text. Also, re-emphasis focus on the development of symbolic understanding (good choice, by the way), as your contribution could just have easily focused on reasoning or memory, for example.

### **Symbolic understanding**

We live in a culture surrounded by symbols, which support our ability to interact with others and successfully navigate our complex social environment. Symbols allow us to represent thoughts, feelings, emotions, and ideas, and critically to communicate them to others. Beyond infancy is an exciting time for **symbolic development**, as children use social cues to help them connect mental representations with referents – things that exist in the real world.

In the western world, one cannot help but be bombarded by symbolic media. Ittleston (1996) captures the preponderance of symbols he faces during a casual morning beautifully: “As I sit here at my breakfast table, my morning newspaper has printing on it; it has a graph telling me how the national budget will be spent, a map trying to tell me something about the weather; a table of baseball statistics, an engineering drawing with which I can build a garden chair, photographs of distant places and people, a caricature expressing what the editor thinks of a political figure ... On the wall in front of me hangs...a calendar [and above it] is a clock. All this and more, and I haven't even turned on the TV or the computer...” (p. 171).

The ability to use symbols is among the most significant developmental achievements that is argued to distinguish human beings from other creatures. Although the capacity to develop symbolic thought might be hard-wired in humans,

symbolic thinking does not emerge at birth fully-fledged. Rather, becoming ‘symbol-minded’ (see DeLoache, 2004) gradually unfolds during the first few years of life, as children acquire experience with different symbolic media and interact with expert symbol users. Three symbolic areas will be discussed here: pictures, gestures, and words.

## **Pictures**

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Very young children (9-15 months) initially explore pictures manually, sometimes confusing them with reality. By the time children are 2 years of age, however, they no longer grasp at pictures, but instead explicitly point to the depictions, reflecting a clearer understanding of the stimuli as two-dimensional. It is during this time that they are beginning to demonstrate the early components of pictorial understanding, including the appreciation that pictures are referential.

In one study, Preissler and Carey (2004) taught 18- and 24-month-old children a new name (“whisk”) for a novel picture of a whisk. Children were presented with the picture they had learned the word for, and a real, previously unseen, whisk, and were asked to show the experimenter a ‘whisk’. Both groups of children selected the real object, or both the picture and the object, but never simply the picture. This shows that the children understood that the purpose of a picture is to *refer* to an object in the real world, and that the label does not simply refer to the picture itself. A simplified version of this paradigm in which children hear a novel label for a highly iconic, color, picture in the context of a more naturalistic picture book interaction reveals that children are beginning to understand this referential connection around

15-months, which appears to be a transitional age at which children no longer merely associate words with pictures and objects (Ganea, et al., 2009).

Several factors influence symbolic understanding of pictures. For instance, children are more likely to treat highly iconic pictures symbolically, transfer information learned from iconic pictures to real world exemplars and recruit verbal labels to help them match pictures to objects. They also benefit from training with an advanced symbol user. Callaghan and Rankin (2002) conducted a longitudinal study; when children were 28 months old, they failed a search task which required them to use pictures containing similar perceptual elements (e.g. a single circle, a circle with radiating spikes, three circles, or a line) to find their corresponding referents (e.g. a plain ball, a 'spider' ball with rubber legs attached, a collection of three balls, or a wooden dowel). The children who received weekly training sessions in which they witnessed the experimenter drawing and highlighting the relation between pictures and referents showed an increase in picture comprehension and production after 2 months. A control group, who received parallel sessions crucially without drawing, did not. Thus, interaction with symbolically experienced adults provides an opportunity for children to implicitly learn the communicative based rules of symbol usage.

However, the most important principle underlying symbolic representation is appreciating the dual aspect of pictures. That Warhol print on your wall might represent Marilyn Monroe, but it also is an object in its own right, framed and occupying real space; this 'dual representation', seems to be a necessary precursor for children's understanding of how pictures work. They have to get past the fact that pictures can be interesting objects in and of themselves, and then to focus on their symbolic capacity.

Two year-olds are able to treat pictures as objects in their own right – or as representations – in different contexts. In one study, children were given a new target picture which was either provided with a novel name “this is a dax!”, or specifically unlabelled “look at this!” (Preissler & Bloom, 2007). When asked to ‘find another one’ from an array of a new picture, an object the new picture represents, and the real object the target picture represents, children categorized the picture by its kind category only when it was labeled. If the picture was not given a name, children tended to select another picture as the likely candidate when asked to ‘find another one’. Thus, they can view pictures as either objects in their own right (‘belonging’ in a sense, with other pictures) or as symbols, belonging with the *depicted* kind and labelling provides a critical cue for honing in on the symbolic interpretation.

At age 2 ½, children can use information in a picture to help them find information in a real world situation. In a classic study, DeLoache and Burns (1994) showed children pictures of elements in a room, such as a chair, sofa, cabinet, etc. They pointed to one of the elements and told children that Snoopy was hiding in that place in his room. They then steered children to a real room that corresponded to the pictures, and asked children to find Snoopy. At age 24-months, children consistently fail this test, but at 30-months they are reliably able to retrieve the toy using the pictorial cue. Of interest is that children are not able to use scale models of the elements in a room (rather than pictures) until 6 months later, due to the fact that the objects are so interesting in and of themselves. However, 30-month-olds can see the models as symbols if they think a ‘shrinking machine’ simply reduced the real room to a tiny replica; in this way, the status of the model is changed to non-symbolic because children believe the model and the real room are the same entity. (Don’t quite follow the second half of this sentence, and how it relates to the first part). Judy

DeLoache interprets these studies as substantial evidence for dual representation, since children need to focus spontaneously on both aspects of the picture or model, as a representation and as an object. This paradigm requires children to utilize information in an online fashion for a problem-solving task, and represents a conceptual leap to becoming a competent symbol user.

By age 4, children can transfer biological information learned from a book to real life, and storybooks have even been successfully used as a method for teaching natural selection in children as young as 5 (Keleman, Emmoms, Schillaci, & Ganea, 2014). Although pictorial understanding continues to develop during the first few years, children still make some errors when it comes to reasoning about pictures. If 3- or 4- year olds are asked if they could eat a picture of an ice cream cone or smell a picture of a flower, sometimes they will say “Yes”. They can also be confused about the stability of the link between pictures and real world referents, thinking that a picture of an array of objects would change if the objects themselves changed. Three- and 4-year-olds also act as if changing the features of a photograph (by putting a sticker on it) changes reality (they expect a corresponding real world referent to thenceforth bear the sticker). Even at 6 years-of-age, some children will assert that a photograph portraying an illogical outcome of an event is a true depiction of reality. Thus, the ability to understand pictures, use them as sources of information, and develop a ‘theory of pictures’ continues to refine during development (see Freeman & Sanger, 1995).

### ***Intentionality or naïve realism?***

This appears to be a sub-section of Pictures. If so, then please put heading in italics. One critical feature that makes pictures so special is that many share a direct and transparent link to the real world. Upon viewing a highly detailed picture of the

Empire State Building, for instance, you would instantly be able to name the depiction, without having to consult the artist's intention or mental state. How children link pictures to their real world counterparts remains a fundamental question to both psychologists and philosophers as picture interpretation itself may be a cultural construction. On the one hand, some theorists claim that the meaning of a picture is determined by its creator ('intentional' theory). Alternatively, pictures can be linked to the world by their resemblance to real world properties ('naïve realism' theory).

Evidence for realism comes from studies that show that highly iconic pictures (such as color photographs) increase the imitation of actions seen in a picture book, and facilitate generalisation of labels from pictures to their real world counterparts. If children are faced with situations where resemblance and intention conflict (e.g., the artist states he is going to draw a picture of a bear, but the resultant depiction looks more like a rabbit), they are guided by resemblance cues when naming the depiction and call it, for instance, a 'rabbit'. When asked forced choice questions, even children aged 11 seem to think that 'pretty things make pretty pictures', thus focusing on the referential content rather than the role of the artist in terms of the depicted outcome.

Abundant evidence also exists, however, to show that children are very sensitive to the creator's intention when deciding what to name, how to categorize, or even how to value pictures. Two and a half year olds, for instance, can use the gaze of an experimenter to link a picture to a real world referent, even when the picture could plausibly refer to more than one object. They only do so, however, during an intentional act of drawing, and not when merely if associative cues are provided. Three- and 4-year old children can also recognize their own pictures after a delay,



even if they are indistinguishable to an adult, which suggests that they can utilize their own intentions to keep track of the identity of their visual depictions. Furthermore, children are sensitive to how a picture was created, and are more likely to use shape as a basis for naming ambiguous pictures if they were created intentionally, rather than accidentally. Thus, young children do consult intentional cues when analysing pictures, but sometimes the iconicity of the picture takes precedence.

The extant literature suggests that one explanation of these findings comes from the divergence of picture type. If the pictures are strongly iconic, they prioritize resemblance cues over artist intention. However, if pictures are ambiguous, children will evaluate an artist's intentional cues as a basis for naming and categorizing pictures. Another way to rectify and complement these experimental findings is to look to a population of children who vary in their intention monitoring ability, specifically, children with Autism Spectrum Disorder (ASD) (what about Williams syndrome? Children with this syndrome reportedly have difficulty in 'holistic processing' of visual displays). The few studies that do exist suggest there are fundamental differences in symbolic understanding, particularly in minimally verbal children who rely upon pictorial systems for communication (Preissler, 2008). They tend not to generalize labels learned from pictures to real world objects, and link pictures to objects based purely on resemblance, suggesting that they are naïve realists when interpreting pictures. It is also possible that children with Williams syndrome, who also tend to process visual displays holistically, but are considered 'hyper' social, display a different route to picture interpretation. This burgeoning area is one to target in future research as it can inform typical and atypical theories of picture development.

## Gestures

Before children begin to produce words, they use **deictic gestures** for communication, such as pointing at a dog. Such gestures have been argued to pave the way for language production (Liskowski, 2012), and to provide a means of establishing common ground with another person to influence mental states. From 10-24 months, children begin to produce symbolic gestures that carry meaning within their form (such as a child putting her thumb to her mouth to indicate ‘bottle’).

It is not until 26-months that children appreciate iconic gestures, which convey attributes associated with an object and can be interpreted without explicit tuition linking them to a referent (such as flapping one’s arms to indicate a flying bird). Before this, it is argued that children simply associate iconic gestures with objects, rather than truly understanding the iconic relation between the two (Özçalışkan & Goldin-Meadow, 2011). Researchers have argued that icons are both distinct from other, more advanced, symbols and a more primitive form of communication, and thus, it is surprising that the ability to understand the meaning of iconic signs develops gradually. In a task asking 2.5 – 5 year-old children to match iconic signs to pictures of referents, Tolar *et al.* (2008) found that very few 2.5 year olds passed the task, around half of 3 year- olds passed the task, but by 3.5 years most children succeeded. By 4.5 all the children succeeded in the task, and significantly outperformed the younger groups (see Fig. 1). The authors suggest that iconic representation is thus a cognitively advanced skill not available to younger language learners.

One of the most ubiquitous gestures that children are able to understand and produce from an early age, however, is pointing. From 2-3.5 years of age, pointing is the most frequent gesture children produce in free-play sessions (Nicoladis,

Mayberry, & Genessee, 1999), and builds upon the precursor of joint attention to objects and events in the environment. Children use pointing to share interest and attention with others, provide help, and support linguistic interactions. Specifically, 3 and 4 year-old children use pointing to clarify potentially unclear re-introductions of story characters, providing non-redundant information for the conversational partner by combining linguistic and paralinguistic means (O'Neill & Holmes, 2002). Even younger children (2 years-old) are able to gesture to solicit help from others. O'Neill (1996) also showed that 2-year-olds will gesture to solicit help. In one study, a toy was placed on a shelf in one of two containers, and the key manipulation was whether parents saw or did not see this event. Children gestured more when parents did not witness the event, suggesting they are using their parents' knowledge state to influence their communicative bids and attempt to manipulate the behavior of others.

There is a progression from age 3 to 5 years in terms of how children represent actions in pantomime, such as pretending to brush their teeth (Boyatzis & Watson, 1993). Whereas the younger children use their own body parts to represent the tool (e.g., using their index finger as the toothbrush), older children tend to move their fingers as if the tool was there (e.g., moving fingers as if holding the toothbrush). This leap occurs for both the comprehension and production of gestures, and suggests that the older children are 'distancing' the symbol from the referent and therefore no longer need to rely upon the physical presence of the tool.

Gestures are also used to support language throughout early development. For instance, hand gestures frequently co-occur with speech during conversation by children and adults, and even in adulthood, individuals abstract meaning and benefit from the gestures speakers produce. Early gesture production has been linked to successful language acquisition; children's vocabulary development at age 3.5 can be

predicted from how many different meanings they convey in gestures at age 18-months. In addition, young children who received parental training that involved modelling and encouraging symbolic sign use showed an increase in language measures before age 3. Thus, gesture is intricately linked to verbal language acquisition; however, it is also widely used as a primary mode of communication by hearing-impaired individuals.

One of the most interesting and influential set of studies in this domain involves a group of deaf children in Nicaragua, who entered a specialized school in 1977. At the time, there was no national educational system for deaf Nicaraguans, and no proffered sign language in use. The most remarkable feat occurred when the first cohort of students entered the school: together they *created their own language* (Senghas & Coppola, 2001) (interesting. Same reported for twins living in isolation and children locked up in orphanages), beginning with home signs they used individually, and refining their language to meet the needs of the wider social group. Importantly, a second cohort of students learned from their older peers and began to refine the language further –breaking signs down into morphological components and making the signs more arbitrary, complex and ‘language-like’. Senghas and Coppola (2001) identified that such changes were initiated by children under the age of 10, suggesting that as a group children have the capacity to learn and, critically, to also create language.

## **Words**

Of course, arguably the most significant symbolic form is the spoken word, and how children acquire the meanings of words has provoked immense debate. Although it appears effortless for most typically developing children, becoming proficient in even

your native language requires an amalgam of processes interacting to support and facilitate lexical development. The philosopher Willard Van Orman Quine (1908-2000) elegantly outlines the problem of word acquisition. Suppose you are in a tribal village and you do not speak a word of the native language. Something that looks like a rabbit runs by through the brush and a villager points to the scene and exclaims “gavagai!” Given the numerous possibilities, what do you take ‘gavagai’ to refer to? This puzzle, known as the indeterminacy of reference, suggests that there are infinite possibilities. Quine points out that you may take the word to refer to rabbit, but it could also refer to furry, small, the motion of running, or the oft-quoted example of ‘undetached’ rabbit parts. It is likely that you would take the word to refer to rabbit, and young children also share this intuition. However, how children reach this conclusion is of debate. One theoretical account claims that children’s word learning success is due in part to the employment of various constraints and biases, which help to guide their early lexical acquisition.

#### *Word learning constraints and their origins*

Word learning constraints, such as the whole object bias, taxonomic bias, and mutual exclusivity assumption, form a rough guide for approximating word meanings, and serve to limit the possibilities and give some priority over others. When a new label is provided in the context of a new object, children assume the word refers to the whole entity (such as a mug), rather than its constituent parts (such as the handle), color, substance or other properties. Children also tend to use labels to categorize objects by kind (e.g., dogs) rather than by thematic relationships (e.g., dog and bone), which is referred to as the taxonomic bias.

The most studied constraint is the assumption that a new word refers to an object that does not already have a name, something known as **mutual exclusivity**.

For instance, children will call a novel object a ‘dax’ if it is presented alongside a familiar object that they already have a label for, such as an apple. This phenomenon has been repeatedly documented in toddlers and pre-schoolers, in bilingual children (where mutual exclusivity is preserved within L1 and L2, but not across the two languages), and in children with disabilities such as Williams syndrome and ASD. Since children can effectively rule-out stimuli in the environment they already have a name for when they hear new words, mutual exclusivity is one of the most important documented biases to facilitate word acquisition. Taken together, word-learning constraints have been argued to be language-specific, although there is no consensus on whether they emerge during the course of language acquisition or are in place at its onset.

However, it is possible that these constraints are recruited from children’s existing abilities that support conceptual development or causal reasoning, and thus might not apply only to language learning (Markman, 1992). That children are able to adhere to the principle of mutual exclusivity when learning new words and also new facts, supports this claim. An alternative viewpoint is that mutual exclusivity, and indeed vocabulary learning in general, arises from general pragmatic principles about a speaker’s referential intent.

#### *Social-pragmatic accounts*

Broadly speaking, the social-pragmatic approach to word learning posits that it is the social-communicative dimension of language scenarios that focuses the child’s attention on the referent of interest in the environment. One account suggests that the child enters into a state of joint focus (attention) with the speaker, and is not as concerned with establishing a label but with trying to figure out *what* it is the adult wants to direct their attention to. Joint attention thus allows the child to share

common ground with their interaction partner (Tomasello, 2008). Paul Bloom has a similar take on word learning in terms of focus on the social dimensions of the language learning situation, but he advocates more heavily that intention reading is key to successful language acquisition, which then results in acts of joint engagement and naming (Bloom, 2000).

Pragmatic accounts of word learning maintain that the interpretation of novel words relies upon the same social and cognitive skills that children use in other (non-lexical) situations in order to interpret other people's verbal and non-verbal behavior. What is specific to language contexts is that children also bring to bear the expectation that speakers are utilizing language conventionally and are expressing their communicative intentions. Pragmatic accounts of language learning would predict that individuals with pragmatic impairment would show difficulties with word acquisition and other aspects of linguistic development, and this is precisely what happens in many individuals with ASD. To mirror the above argument regarding picture interpretation, examining atypical populations who differ in pragmatic and intention monitoring skills can provide the right kind of evidence to bear upon existing theories, and should be evaluated in tandem with empirical studies of typical cases of language development.

### **Fast or slow mapping?**

In addition to considering the constraints vs. social-pragmatic approach for word learning, recent work has debated the time course of word acquisition, specifically how many exposures children might need to learn a new word, and whether instances of initial referent selection equate to real word learning. These questions are important when we consider the remarkably impressive timescale of word learning; children know approximately 60,000 words by the time they enter high school,

produce 300 words by their second birthday, and have been shown to learn a word in a single exposure (termed ‘fast mapping’). In a seminal study and one of the first to document the phenomenon, Carey and Bartlett (1978) asked 3- and 4-year old children to “Bring me the chromium tray, not the blue one, the chromium one”. Children were remarkably good at retrieving an olive colored tray, even though this novel word was introduced in an indirect way. More impressive was the fact that half the children remembered something about the meaning of the word when tested a week later. Children do not need an explicit contrast to learn words, and fast mapping has been repeatedly documented from the age of two.

Recent work on associative learning contests the interpretation that children are efficient word learners. Researchers have made the distinction between initial fast mapping and subsequent word retention, and argue that although children are good at the former, they are much less proficient at the latter, which arises from a slow associative (Hebbian) process that requires repetitive learning. Some of the differences can be attributed to experimental design; many of the associative learning paradigms require children to learn numerous new words, rather than one or two, and having to maintain several new words and novel referents in working memory, map the words to their appropriate referents, and encode the correct pairs into long-term memory might prove too challenging for younger children in experimental settings. Nonetheless, it will be important for researchers to incorporate tests after a delay to help to explain the discrepant results and inform future theory.

**Origins of symbolic understanding: Domain-general vs. domain-specific accounts**



One central question arises when we look at the origins of symbolic understanding as a whole: are such skills across various domains independent (domain-specific) or do they instead arise from a common source (domain-general)? For instance, traditional accounts of language development following the work of Noam Chomsky posit that language arises from a specialized mechanism and is unique to humans. The evidence that lends support to this domain-specific argument includes homogeneous language learning across cultures despite significant variation in input and in the learners themselves. A strict, domain-specific account of symbolic development would predict that the understanding and use of gesture, words, pictures, models and maps arise independently. The fact that these skills surface in a specific temporal sequence (e.g., gestures occur before the other skills) supports this idea. However, a growing body of evidence for domain-general symbolic substrates comes from both the onset and inter-relatedness of skills across a developmental trajectory. On this account, it is experience that mediates the emergence of each of the skills across different time points, although they all stem from the same source (see Fig. 2).

The capacity of words and gestures as symbols appears to emerge in synchrony, but then specializes over time with particular input (e.g., 18 month-old children are equally likely to interpret gestures or words as names for object categories, but at 26 months-of-age, only the words retain symbolic power). Brain-related activity for words and gestures follows this pattern; in 18-month-olds, an N400 mismatch effect was found when words and gestures preceded pictures, but by 26 months, the effect was only observed for words (Sheehan, Namy, & Mills, 2007). This suggests both gestures and words emerge from a single underlying ability (see also Allen, Mattock & Silva, 2014 for related evidence involving words and pictures), but experience is crucial for fine-tuning a particular symbolic form. In support of

this, when Namy and Waxman (2002) examined young children's production of gestures and words, they found that although children were able to readily produce both forms at 26 months, only the words were referential.

Additional intricate links between language and other symbolic domains have been found. For instance, language appears to moderate symbolic understanding of pictures and is linked to symbolic play, suggesting language may provide a base to scaffold skills in other symbolic domains. It is also possible that skills arise in parallel but then diverge after children reach a certain level of competency in each. In support of this, a recent study showed that language, graphic symbolism and symbolic play were interrelated in 4 year-olds, suggesting domain-general development, but only a year later only language retained predictive validity (Kirkham, Stewart, & Kidd, 2013). The implication then is that language mediates both play and graphic production, and becomes 'progressively internalized'. It will be important for future work to document the early development of symbolic skills across multiple modalities to determine predictive factors and examine the role that core cognitive capacities such as memory and attention play in terms of symbolic development.

## **Conclusions**

In summary, the post-infancy period sees the rapid development of language and symbolic understanding across multiple domains. Competence in each symbolic area develops gradually, which reflects an interaction between experience with symbolically advanced peers and adults and cognitive maturation. A growing body of literature suggests symbolic skills may share a distinct source, and future work should target both the onset and directionality of influence between symbolic substrates. Given the rapid technological advances and the introduction of the Apple iPad in 2010, it will be important going forward to also analyse the benefits of learning from

such media (see Fig. 3). For example, many unsubstantiated claims exist about the learning potential of the iPad, and although the dynamic nature of it may boost motivation to engage with the device, the effects on learning vocabulary and other symbolic skills such as picture-word relations are unclear. It is also evident that work from atypical populations can both inform different developmental trajectories and complement theories of typical development.

**See also: Constructivist theories; Learning theories; Longitudinal and cross-sectional designs; Cognitive development during infancy; Learning and memory; Language acquisition; Social development; Joint attention; Educational neuroscience; Autism; Williams syndrome; Linguistics**

### **Further reading**

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